

POWER REQUIREMENTS FOR COMMUNITY DIAL
CENTRAL OFFICE EQUIPMENT

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1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It discusses in particular the methods used in calculating the power requirements for dial central offices. It provides means to calculate the required capacities of the storage batteries and charging equipment for particular applications.

1.2 This revision replaces REA TE&CM 302, Issue No. 3, dated January 1962. It is being reissued to include power calculation methods for various common control equipment, tone dialing equipment and toll ticketing equipment.

1.3 Paragraphs 17.0 and 18.0, respectively, of Part III, REA Form 558c, "Detailed Central Office Equipment Requirements," and paragraphs 8.1 and 8.2, respectively, of Part III, REA Form 524c, "Specification for Common Control Central Office Equipment Detailed Equipment Requirements," cover the general specifications governing the supply, by the manufacturer, of storage battery and charging equipment for use with an REA borrower's proposed dial central office (CDO). Based upon these general specifications, determination of the required capacities of the battery and charger is made by the manufacturer.

2. BASIS FOR CALCULATIONS

2.1 The charging equipment furnished with a dial central office must have sufficient capacity to supply the dc power necessary for the satisfactory operation of the office during the busy hour. This is exclusive of the power requirements for any ac equipment but includes the dc requirements for carrier, loop extenders, voice frequency repeaters, ANI, etc.

2.12 Determination of the requirements for emergency generating and charging equipment is covered in REA TE&CM 320, "Emergency Generating and Charging Equipment."

2.2 Charging equipment for common control offices should be provided on one of the following bases:

- (a) Two chargers either capable of carrying the full office load, or
- (b) Three chargers each capable of carrying half the office load.

(See Exhibit E for example.)

Although required for common control offices only, this arrangement may be desirable for larger size direct control offices. If so, it should be noted in paragraph 23 of REA Form 558.

2.3 Storage Battery

2.31 The storage battery furnished with a dial central office must have sufficient capacity to supply the dc power necessary to sustain satisfactory operation of the exchange for the period specified in paragraph 17.0 of REA Form 558c, or paragraph 8.1 of REA Form 524c, in the event of failure of the commercial (ac) power supply. This includes appropriate allowances for any equipment which is normally ac operated but arranged for dc operation in case of a power failure.

3. CALCULATIONS

3.1 Attached Exhibits A through N outline the procedures to be followed in calculating the power requirements (charger and battery) for dial central office equipment of the following types:

Exhibit A: Switch Type Equipment as Manufactured by Automatic Electric, ITT and Stromberg-Carlson

North Electric NX-2A Crossbar Equipment

Leich All-Relay Equipment

Exhibit B: Stromberg-Carlson ESC-1

Exhibit C: Stromberg-Carlson ESC-3

Exhibit D: ITT A-1

Exhibit E: ITT PC-32B

Exhibit F: Automatic Electric CXP-5

Exhibit G: Automatic Electric No. 1 - EAX

Exhibit H: North Electric NX-1D

Exhibit I: North Electric NX-1E

Exhibit J: Northern Electric SP-1

Exhibit K: Nippon Electric NC-23, NC-400, and NC-460

Exhibit L: Stromberg-Carlson Toll Ticketing

Exhibit M: ITT Tel Touch

Exhibit N: Stromberg-Carlson Tone Dialing

2 Exhibit O: Lists various power requirements for loop extenders, voice frequency repeaters and carrier equipment.

3 Exhibit P: Illustrates the method used in determining the capacity of the storage battery required for a particular application. This exhibit also illustrates, in Example 2, a method used to calculate the reserve hour reserve of existing batteries when the current requirement of the central office equipment is changed as a result of equipment additions, higher than anticipated calling rates, etc.

4 In connection with the calculation of the required capacity of the charger, a ten (10) percent allowance is made, i.e., if 110 percent of the rated output of the charger is equal to or greater than the calculated charger dc current requirement, the charger supplied shall be considered as satisfactorily meeting the specification requirements.

5 In some cases a voltage regulator is added in series with the battery supply of the central office to maintain float voltage during ac power outages. These voltage regulators are electronic dc/dc converters which sense the battery voltage and add additional voltage to maintain the office at float voltage. They automatically disconnect the load just before the batteries are discharged to prevent permanent damage may result. The maintenance on voltage regulators is very low, making them desirable for use in unattended offices. The power required to operate the converter plus the additional power to raise the battery voltage to float voltage during discharge make it necessary to increase the ampere hour rating of the battery as specified in this section by 23 percent. The normal charger capacity should be increased by 10 percent.

5 When Automatic Number Identification is installed in a central office, the additional current drain on the dc supply is as follows:

Two amperes for the common equipment, and 0.3 amperes for the interoffice trunk associated with the ANI equipment.

3.7 It should be kept in mind that the calculation methods shown in this section are to provide estimates only. Engineering judgment must be used for each individual application. It is, therefore, recommended that the manufacturers of the systems being considered be consulted for specific applications.

EXHIBIT A

Busy Hour Current Drain Calculations
for Various Switchboards
(All Values in Amperes)

| Type of Drain | Switch Type (XY, SxS) | North NX-2A Crossbar | Leich Dial (Linefinder- Selector- Connector) |
|--|---|--|---|
| Equipment Holding (See Note 1) | 0.72/T.C.U. | 0.6/T.C.U. (See Note 5) | 1.17/T.C.U. |
| General Operating | 0-100 Lines 1.0 101-200 Lines 1.5 201-400 Lines 2.0 401+ Lines 3.0 | 1st Line Group 1.0 Each Add'l. Line Group 0.5 | 4.0 |
| Additional Equipment | - | - | 0.3/100 Lines |
| Manual Toll Board | 2.0/Position | 2.0/Position | 2.0/Position |
| DC Operated Ringing Generator (See Note 2) | 0-100 Lines 2.0 101+ Lines 3.0 | 3.0 | 0-100 Lines 2.0 101+ Lines 3.0 |
| Interoffice Trunk Circuit | 0.35/2W & 1W Incoming Trunk 0.30/1W Outgoing Trunk (See Note 4) | 0.25/Trunk (See Note 4) | 1.06 (See |
| Special Equipment (See Note 3) | As Required | As Required | As R |

EXHIBIT A NOTESNotes:

1. A "Time Call" Unit is calculated as follows:

$$T.C.U. = \frac{\text{Unit Calls Per Line} \times \text{Total Number of Lines}}{36}$$

2. When the primary ringing generator is ac operated, no provision need be made in the charger capacity to handle the standby ringing generator. The generator drain must be included when calculating battery capacity.
3. This includes the power requirements for carrier, loop extenders, voice frequency repeaters, ANI, etc., (see Exhibit O). Where special equipment is normally ac operated and requires dc only for standby, no provision need be made in the charger capacity. The drain must be included when calculating battery capacity.
4. If the number of interoffice trunk groups equals four or more for switch type equipment (more than four for NX-2A), it is satisfactory to use three-quarters (3/4) of the total trunk circuit current drain.
5. When conversation time disconnect is equipped, add 0.2 amperes per T.C.U. to the holding drain.
6. A Trunk "Time Call" Unit (T.T.C.U.) is calculated as follows:

$$T.T.C.U. = \frac{\text{Unit Call Capacity of Trunk Group (P.01)}}{36}$$

7. If the total busy hour drain is not in excess of ten percent above a standard charger size, that charger may be used. If the above total exceeds ten percent, the next larger standard charger size should be used.

Examples:

The following office will be used in each of these examples. Assume a 360 line office has a calling rate of 2.0 unit calls per line with 6 two-way toll trunks and 8 two-way EAS trunks terminated on incoming selectors. Also assume that dc operated carrier and VF repeaters have a drain of 3 amperes. The primary ringing generator is ac operated in Examples 1 and 3.

$$T.C.U. = \frac{2.0 \text{ UC/L} \times 360 \text{ Lines}}{36} = 20$$

Exhibit A Examples Continued

1. Switch Type Equipment:

| | |
|--|------------------|
| Equipment Holding Drain = 20×0.72 | = 14.4 |
| General Operating Drain | = 2.0 |
| No Toll Board | - |
| Primary Ringing Generator - AC Operated | - |
| Trunk Drain = 14×0.35 | = 4.9 |
| Special Equipment Drain | = 3.0 |
| Total Drain | <u>24.3</u> Amps |

2. North NX-2A Crossbar:

| | |
|---|------------------|
| Equipment Holding Drain = 20×0.6 | = 12.0 |
| General Operating Drain = $1.0 + \frac{270}{90} \times 0.5$ | = 2.5 |
| Primary Ringing Generator - DC Operated | = 3.0 |
| Trunk Drain = 14×0.25 | = 3.5 |
| Special Equipment Drain | = 3.0 |
| Total Drain | <u>24.0</u> Amps |

3. Leich Dial:

| | |
|---|------------------|
| Equipment Holding Drain = 20×1.17 | = 23.4 |
| General Operating Drain | = 4.0 |
| Additional Equipment Drain = $\frac{360}{100} \times 0.3$ | = 1.1 |
| Primary Ringing Generator - AC Operated | - |
| Trunk Drain: | |
| 6 Toll Trunks (P.01) will handle 64.4 UC | |
| Toll Group Drain = $\frac{64.4}{36} \times 1.08$ | = 1.9 |
| 8 EAS Trunks (P.01) will handle 105 UC | |
| EAS Group Drain = $\frac{105}{36} \times 1.08$ | = 3.2 |
| Special Equipment Drain | = 3.0 |
| Total Drain | <u>36.6</u> Amps |

The above total drains should be used in determining charger size. For calculating battery capacity three amperes should be added to Examples 1 and 3 to account for ringing generator current drain.

EXHIBIT B

Stromberg-Carlson ESC-1

| Equipment | 48-Volt Drain | | | 8-Volt Drain | | |
|---|--------------------|------------------------|------------------|--------------------|------------------------|------------------|
| | No. of Units | Amperes Per Unit | Total Current | No. of Units | Amperes Per Unit | Total Current |
| Common Control (Local) Cabinets (CCL) 1 | - | - | - | - | 16 | - |
| 4-Stage Trunk Link Network (TLN) | - | 93 | - | - | - | - |
| 6-Stage Trunk Link Network (TLN) | - | 102 | - | - | - | - |
| Common Control (Trunk) Cabinets (CCT) | - | 10 | - | - | 7 | - |
| Register Sender Cabinets (RS) | - | 1 | - | - | 10 | - |
| Auxiliary Register Sender Cabinets (RSA) | - | 3 | - | - | 10 | - |
| Translator Cabinets | - | 5 | 5 | - | 42 | 42 |
| TLN Cabinet (Control) (TLC) | 1 | 10 | 10 | 1 | 8 | 8 |
| Supervisory Cabinet (CSR) | 1 | 6 | 6 | 1 | 12 | 12 |
| Powerboard (1 Frequency) | - | 7 | - | - | - | - |
| (2 Frequencies) | - | 9 | - | - | - | - |
| (4 Frequencies) | - | 15 | - | - | - | - |
| Automatic Call Generator | 1 | 3 | 3 | 1 | 5 | 5 |
| DC-DC Converter (-24v) 2 | - | 11 | - | - | - | - |
| Loop Extender Power Supply 2 | - | 4 | - | - | - | - |
| Pre-Pay Power Supply | - | 2 | - | - | - | - |
| Tandem Trunks 3 | - | .015 | - | - | - | - |
| Recording Trunks | - | Note 4 | - | - | Note 4 | - |
| LAMA Cabinets | - | 24 | - | - | 16 | - |
| CAMA Cabinets | - | 13 | - | - | 7 | - |
| Maintenance Test Console | - | 5 | - | - | 2 | - |
| Registers | - | - | - | - | 1 | - |
| Senders | - | - | - | - | 1 | - |
| Customer Drain | - | As Req'd. | - | - | As Req'd. | - |
| Total Drain | 48-Volt | | | 8-Volt | | |

EXHIBIT B NOTESNotes:

1. When the number of line units are odd, round off to next even number.
2. Do not include drain for redundant equipment.
3. Incoming Tandem Trunk CCS X .015 = Total Current
- 4.

| <u>Recording Trunks Equipped</u> | <u>Drain in Amperes</u> | |
|--------------------------------------|-------------------------|---------------|
| | <u>48-Volt</u> | <u>8-Volt</u> |
| 1 - 50 | 7 | 57 |
| 51 - 100 | 8 | 68 |
| 101 - 150 | 9 | 79 |
| 151 - 200 | 10 | 90 |
| 201 - 250 | 11 | 102 |
| 251 - 300 | 13 | 113 |
| 301 - 350 | 14 | 124 |
| 351 - 400 | 15 | 136 |

5. When SCAMA-LAMA ticketing is required, the following drains should be added:

| <u>Ultimate DDD Trunk Capacity</u> | <u>8V Drain</u> | <u>48V Drain</u> |
|--|---------------------|----------------------|
| 50 | 57 amps | 7 amps |
| 100 | 68 | 8 |
| 150 | 79 | 9 |
| 200 | 90 | 10 |
| 250 | 111 | 11 |
| 300 | 113 | 13 |
| 350 | 124 | 14 |
| 400 | 136 | 15 |

6. When CAMA is required, the following drains should be added:

48V Drain - 24 amps
8V Drain - 16 amps

EXAMPLE

Stromberg-Carlson ESC-1
1500 Lines
5000 Directory Numbers

| Equipment | 48-Volt Drain | | | 8-Volt Drain | | |
|---|--------------------|------------------------|------------------|--------------------|------------------------|------------------|
| | No. of Units | Amperes Per Unit | Total Current | No. of Units | Amperes Per Unit | Total Current |
| Common Control (Local) Cabinets (CCL) 1 | - | - | - | 1 | 16 | 16 |
| 4-Stage Trunk Link Network (TLN) | 1 | 93 | 93 | - | - | - |
| 6-Stage Trunk Link Network (TLN) | | 102 | | - | - | - |
| Common Control (Trunk) Cabinets (CCT) | 1 | 10 | 10 | 1 | 7 | 7 |
| Register Sender Cabinets (RS) | 1 | 1 | 1 | 1 | 10 | 10 |
| Auxiliary Register Sender Cabinets (RSA) | | 3 | | | 10 | |
| Translator Cabinets | - | 5 | 5 | - | 42 | 42 |
| TLN Cabinet (Control) (TLC) | 1 | 10 | 10 | 1 | 8 | 8 |
| Supervisory Cabinet (CSR) | 1 | 6 | 6 | 1 | 12 | 12 |
| Powerboard (1 Frequency) | | 7 | | - | - | - |
| (2 Frequencies) | | 9 | | - | - | - |
| (4 Frequencies) | 1 | 15 | 15 | - | - | - |
| Automatic Call Generator | 1 | 3 | 3 | 1 | 5 | 5 |
| DC-DC Converter (-24v) 2 | 1 | 11 | 11 | - | - | - |
| Loop Extender Power Supply 2 | 2 | 4 | 8 | - | - | - |
| Pre-Pay Power Supply | 2 | 2 | 4 | - | - | - |
| Tandem Trunks 3 | 100 CCS | .015 | 1.5 | - | - | - |
| Recording Trunks | | Note 4 | | | Note 4 | |
| LAMA Cabinets | | 24 | | | 16 | |
| CAMA Cabinets | 1 | 13 | 13 | 1 | 7 | 7 |
| Maintenance Test Console | 1 | 5 | 5 | 1 | 2 | 2 |
| Registers | - | - | - | 80 | 1 | 80 |
| Senders | - | - | - | 20 | 1 | 20 |
| Customer Drain | | As Req'd. | 15 | | As Req'd. | |
| Total Drain | 48-Volt | | 200.5 | 8-Volt | | 209 |

EXHIBIT C

Stromberg-Carlson ESC-3

| Equipment | 48-Volt Drain | | | 8-Volt Drain | | |
|---|--------------------|------------------------|------------------|--------------------|------------------------|------------------|
| | No. of Units | Amperes Per Unit | Total Current | No. of Units | Amperes Per Unit | Total Current |
| Common Control Cabinet | | 23.8 | | | 48.6 | |
| Translator | | 4.2 | | | 77.7 | |
| Test Cabinet | | 3.7 | | | 10.0 | |
| Power Supervisory | | 24.7 | | - | - | - |
| Register Common | - | - | - | | 12.0 | |
| Call Generator | | 0.6 | | | 4.8 | |
| MF Current Supply | | 2.8 | | - | - | - |
| Each Register (Max. 48) | | 0.2 | | | 1.3 | |
| Each Sender (Max. 20) | - | - | - | | 1.0 | |
| Each Tone Dial Detector | | 0.43 | | - | - | - |
| Each 1,000 Directory Numbers | - | - | - | | 5.6 | |
| Each Toll MF Detector | | 0.5 | | - | - | - |
| +48v Message Registration | | 3.5 | | - | - | - |
| +48v Paystation Coin Control | | 1.5 | | - | - | - |
| Aux. Common Control Cabinet | | 6.8 | | | 16.6 | |
| Aux. Line/Trunk Marker | | 4.2 | | | 14.0 | |
| Each Line Unit (1350 CCS) | | 20.3 | | - | - | - |
| Each Line Unit (2000 CCS) | | 30.0 | | - | - | - |
| Loop Extender Power Supply (3 amps per 49 loops) | | 3.0 | | - | - | - |
| Customer Drain | | As Req'd. | | | As Req'd. | |
| Total Drain | 48-Volt | | | 8-Volt | | |

EXAMPLE

Stromberg-Carlson ESC-3
500 Lines
1000 Directory Numbers

| Equipment | 48-Volt Drain | | | 8-Volt Drain | | |
|---|--------------------|------------------------|------------------|--------------------|------------------------|------------------|
| | No. of Units | Amperes Per Unit | Total Current | No. of Units | Amperes Per Unit | Total Current |
| Common Control Cabinet | 1 | 23.8 | 23.8 | 1 | 48.6 | 48.6 |
| Translator | 1 | 4.2 | 4.2 | 1 | 77.7 | 77.7 |
| Test Cabinet | 1 | 3.7 | 3.7 | 1 | 10.0 | 10.0 |
| Power Supervisory | 1 | 24.7 | 24.7 | - | - | - |
| Register Common | - | - | - | 1 | 12.0 | 12.0 |
| Call Generator | 1 | 0.6 | .6 | 1 | 4.8 | 4.8 |
| MF Current Supply | 1 | 2.8 | 2.8 | - | - | - |
| Each Register (Max. 48) | 8 | 0.2 | 1.6 | 8 | 1.3 | 10.4 |
| Each Sender (Max. 20) | - | - | - | 5 | 1.0 | 5.0 |
| Each Tone Dial Detector | - | 0.43 | - | - | - | - |
| Each 1,000 Directory Numbers | - | - | - | 1 | 5.6 | 5.6 |
| Each Toll MF Detector | - | 0.5 | - | - | - | - |
| +48v Message Registration | - | 3.5 | - | - | - | - |
| +48v Paystation Coin Control | - | 1.5 | - | - | - | - |
| Aux. Common Control Cabinet | - | 6.8 | - | - | 16.6 | - |
| Aux. Line/Trunk Marker | - | 4.2 | - | - | 14.0 | - |
| Each Line Unit (1350 CCS) | 1 | 20.3 | 20.3 | - | - | - |
| Each Line Unit (2000 CCS) | - | 30.0 | - | - | - | - |
| Loop Extender Power Supply (3 amps per 49 loops) | 1 | 3.0 | 3.0 | - | - | - |
| Customer Drain | - | As Req'd. | 10.0 | - | As Req'd. | - |
| Total Drain | 48-Volt | | 94.7 | 8-Volt | | 174.1 |

EXHIBIT D

ITT A-1 Pentaconta

I. Speech Path Drain

| | | | |
|-------------------|--|-----------|---------------------|
| CCS (Intraoffice) | | x 0.007 = | |
| CCS (Outgoing) | | x 0.007 = | |
| CCS (Incoming) | | x 0.008 = | |
| Total | | | = Speech Path Drain |

II. Register-Sender Drain

| | BHC | RHT | BHCx RHT | | |
|-------------------|-----|-----|-------------|------------|----------------|
| Intraoffice Calls | | | | x 0.0008 | |
| Outgoing Calls | | | | | |
| Assistance | | | | | |
| CAMA | | | | | |
| TSPS | | | | | |
| EAS | | | | | |
| Other | | | | | |
| Total Outgoing | | | | x 0.0014 = | |
| Incoming Calls | | | | | |
| DDD | | | | | |
| EAS | | | | | |
| Other | | | | | |
| Total Incoming | | | | x 0.0008 = | |
| Total | | | | | = R-S Drain |

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

Exhibit D - Continued

III. Marker Drain

| | | | |
|-------------------|--|------------|--|
| BHC (Intraoffice) | | x 0.0085 = | |
| BHC (Outgoing) | | x 0.0026 = | |
| BHC (Incoming) | | x 0.0057 = | |
| Total | | | |

= Marker Drain

IV. Connector Drain

| | | | |
|--------------------|--|---------|--|
| Total Marker Drain | | x 0.2 = | |
|--------------------|--|---------|--|

= Connector Drain

V. Customer Equipment Drain

As Required

Total Current Drain equals sum of I through V.

EXHIBIT E

ITT PC-32B

I. Speech Path Drain

| | | | |
|-------------------|--|-----------|---------------------|
| CCS (Intraoffice) | | x 0.022 = | |
| CCS (Outgoing) | | x 0.017 = | |
| CCS (Incoming) | | x 0.017 = | |
| Total | | | = Speech Path Drain |

II. Register-Sender Drain

| | BHC | RHT | BHC x RHT | |
|-------------------|-----|-----|--------------|-------------|
| Intraoffice Calls | | | | x 0.00014 = |
| Outgoing Calls | | | | |
| Assistance | | | | |
| CAMA | | | | |
| TSPS | | | | |
| EAS | | | | |
| Other | | | | |
| Total Outgoing | | | | x 0.00021 = |
| Incoming Calls | | | | |
| DDD | | | | |
| EAS | | | | |
| Other | | | | |
| Total Incoming | | | | x 0.00056 = |

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

Exhibit E continued

III. Marker Drain

| | | | |
|-------------------|--|------------|----------------|
| BHC (Intraoffice) | | | |
| BHC (Outgoing) | | | |
| BHC (Incoming) | | | |
| Total BHC | | x 0.0019 = | = Marker Drain |

IV. Customer Equipment Drain

As Required

Total Current Drain Equals Sum of I through IV.

ITT A-1 Pentaconta
& PC-32B

Example

The following information is used to demonstrate the method used to calculate the current drain of the ITT A-1 and PC-32B systems.

| | | |
|--------------------------|------------|----------|
| 2000 Lines | | |
| 1.6 CCS/Line Originating | | |
| Outgoing Trunk Traffic | | |
| Assistance | 200 CCS | 67 BHC |
| CAMA | 400 CCS | 167 BHC |
| EAS | 800 CCS | 533 BHC |
| Incoming Trunk Traffic | | |
| DDD | 600 CCS | 250 BHC |
| EAS | 800 CCS | 533 BHC |
| Intraoffice Traffic | 1800 CCS | 1500 BHC |
| Register Holding Times | | |
| Assistance | 5 Seconds | |
| CAMA | 17 Seconds | |
| Outgoing EAS | 14 Seconds | |
| DDD | 7 Seconds | |
| Incoming EAS | 7 Seconds | |
| Intraoffice | 14 Seconds | |
| Customer Equipment Drain | 40 Amps | |

EXAMPLE

ITT A-1 Pentaconta

I. Speech Path Drain

| | | | | |
|-------------------|------|-----------|------|---------------------|
| CCS (Intraoffice) | 1800 | x 0.007 = | 12.6 | |
| CCS (Outgoing) | 1400 | x 0.007 = | 9.8 | |
| CCS (Incoming) | 1400 | x 0.008 = | 11.2 | |
| Total | | | 33.6 | = Speech Path Drain |

II. Register-Sender Drain

| | BHC | RHT | BHCx RHT | | |
|-------------------|------|-----|-------------|------------|-------------|
| Intraoffice Calls | 1500 | 14 | 21,000 | x 0.0008 | 16.8 |
| Outgoing Calls | | | | | |
| Assistance | 67 | 5 | 335 | | |
| CAMA | 167 | 17 | 2839 | | |
| TSPS | | | | | |
| EAS | 533 | 14 | 7462 | | |
| Other | | | | | |
| Total Outgoing | 767 | | 10,636 | x 0.0014 = | 14.9 |
| Incoming Calls | | | | | |
| DDD | 250 | 7 | 1750 | | |
| EAS | 533 | 7 | 3731 | | |
| Other | | | | | |
| Total Incoming | 783 | | 5481 | x 0.0008 = | 4.4 |
| Total | | | | | 36.1 |
| | | | | | = R-S Drain |

BHC = Number of Busy Hour Calls
 RHT = Register-Sender Holding Time

EXAMPLE - Continued

III. Marker Drain

| | | | |
|-------------------|------|------------|------|
| BHC (Intraoffice) | 1500 | x 0.0085 = | 12.8 |
| BHC (Outgoing) | 767 | x 0.0026 = | 2.0 |
| BHC (Incoming) | 783 | x 0.0057 = | 4.5 |
| Total | | | 19.3 |

= Marker Drain

IV. Connector Drain

| | | | |
|--------------------|------|---------|-----|
| Total Marker Drain | 19.3 | x 0.2 = | 3.9 |
|--------------------|------|---------|-----|

= Connector Drain

V. Customer Equipment Drain

As Required

40 AMPS

Total Current Drain equals sum of I through V.

$$33.6 + 36.1 + 19.3 + 3.9 + 40.0 = 132.9 \text{ AMPS}$$

From the above ampere drain it is seen that either two 150 amp chargers or three 75 amp chargers should be provided. For a three-hour reserve, a 660 ampere-hour battery is required. (From Exhibit P, a final cell voltage 1.85 yields a factor of 4.7 for a three-hour reserve. Therefore, $4.7 \times 132.9 = 625 \text{ AH}$. The next larger size is 660 AH.)

EXAMPLE

ITT PC-32B

I. Speech Path Drain

| | | | | |
|-------------------|------|-----------|------|---------------------|
| CCS (Intraoffice) | 1800 | x 0.022 = | 39.6 | |
| CCS (Outgoing) | 1400 | x 0.017 = | 23.8 | |
| CCS (Incoming) | 1400 | x 0.017 = | 23.8 | |
| Total | | | 87.2 | = Speech Path Drain |

II. Register-Sender Drain

| | BHC | RHT | BHC x RHT | | |
|-------------------|------|-----|--------------|-------------|-----------------|
| Intraoffice Calls | 1500 | 14 | 21,000 | x 0.00014 = | 2.9 |
| Outgoing Calls | | | | | |
| Assistance | 67 | 5 | 335 | | |
| CAMA | 167 | 17 | 2839 | | |
| TSPS | | | | | |
| EAS | 533 | 14 | 7462 | | |
| Other | | | | | |
| Total Outgoing | 767 | | 10,636 | x 0.00021 = | 2.2 |
| Incoming Calls | | | | | |
| DDD | 250 | 7 | 1750 | | |
| EAS | 533 | 7 | 3731 | | |
| Other | | | | | |
| Total Incoming | 783 | | 5481 | x 0.00056 = | 3.1 |
| Total | | | | | 8.2 = R-S Drain |

BHC = Number of Busy Hour Calls
 RHT = Register-Sender Holding Time

EXAMPLE continued

III. Marker Drain

| | | | | |
|-------------------|------|------------|-----|----------------|
| BHC (Intraoffice) | 1500 | | | |
| BHC (Outgoing) | 767 | | | |
| BHC (Incoming) | 783 | | | |
| Total BHC | 3050 | x 0.0019 = | 5.8 | = Marker Drain |

IV. Customer Equipment Drain

As Required

40 AMPS

Total Current Drain Equals Sum of I through IV.

$$87.2 + 8.2 + 5.8 + 40.0 = 141.2 \text{ AMPS}$$

EXHIBIT F

Automatic Electric CXP-5

Subscriber Lines x CCS/Line =

_____ x _____ = _____

Delay Dial Trunks CCS = _____

Local Register-Sender CCS = _____

Non-Delay Dial Trunk Register-Sender CCS = _____

Total CCS = _____

0.037 x Total CCS = Peak BH Drain

0.037 x _____ = _____ (A)

Trunks (See Note)

| <u>Type</u> | <u>Number</u> | <u>Drain</u> |
|-----------------|---------------|--------------|
| 1W Incoming DD | _____ x 0.30 | = _____ |
| 1W Incoming NDD | _____ x 1.25 | = _____ |
| 2W DD | _____ x 0.15 | = _____ |
| 2W NDD | _____ x 0.62 | = _____ |
| CAMA or SATT | _____ x 0.14 | = _____ |
| Coin Completion | _____ x 0.35 | = _____ |

Total Trunk Drain _____ (B)

Note: Do not include 1-way outgoing trunks other than CAMA or SATT.

DD = Delay Dial

NDD = Non-Delay Dial

Common Equipment

| | |
|--|-------|
| Common Control and General Office Drain | 6.0 |
| Ringing Generators (5 Freq. 15W-3A, 25W-5A, 50W-13A) | _____ |
| (1 Freq. 15W-0.6A, 25W-1A, 50W-1.8A) | _____ |

Detection Equipment (Type 70A - 4 amps/system)

Customer Equipment (Carrier, loop extenders, etc.)

Total Common Equipment Drain _____ (C)

Total CXP-5 Drain = 0.8 x $\boxed{A + B + C}$

= 0.8 x _____ = _____

Automatic Electric
CXP-5

Example

The following information is used to demonstrate the method used to calculate the current drain of the Automatic Electric CXP-5 system.

2000 Lines
1.6 CCS/Line Originating
Delay Dial Trunks CCS 1000
Local Register Sender CCS 1800
Non-Delay Dial Trunk Register-Sender CCS 400
10 1W Incoming DD Trunks
5 1W Incoming NDD Trunks
20 2W DD Trunks
5 2W NDD Trunks
15 CAMA Trunks
5 Coin Completion
Ringing Generator - 5 Frequency - 25 Watt
One 70A System
40 amps Customer Equipment

EXAMPLE

Automatic Electric CXP-5

Subscriber Lines x CCS/Line =

$$\underline{2000} \times \underline{1.6} = \underline{3200}$$

Delay Dial Trunks CCS

$$= \underline{1000}$$

Local Register-Sender CCS

$$= \underline{1800}$$

Non-Delay Dial Trunk Register-Sender CCS =

$$= \underline{400}$$

$$\text{Total CCS} = \underline{6400}$$

0.037 x Total CCS = Peak BH Drain

$$0.037 \times \underline{6400} = \underline{236.8} \text{ (A)}$$

Trunks (See Note)

| <u>Type</u> | <u>Number</u> | | <u>Drain</u> |
|-----------------|---------------|----------|--------------|
| 1W Incoming DD | <u>10</u> | x 0.30 = | <u>3.0</u> |
| 1W Incoming NDD | <u>5</u> | x 1.25 = | <u>6.3</u> |
| 2W DD | <u>20</u> | x 0.15 = | <u>3.0</u> |
| 2W NDD | <u>5</u> | x 0.62 = | <u>3.1</u> |
| CAMA or SATT | <u>15</u> | x 0.14 = | <u>2.1</u> |
| Coin Completion | <u>5</u> | x 0.35 = | <u>1.8</u> |

$$\text{Total Trunk Drain} \quad \underline{19.3} \text{ (B)}$$

Note: Do not include 1-way outgoing trunks other than CAMA or SATT.

DD = Delay Dial

NDD = Non-Delay Dial

Common Equipment

Common Control and General Office Drain 6.0
 Ringing Generators (5 Freq. 15W-3A, 25W-5A, 50W-13A) 5.0
 (1 Freq. 15W-0.6A, 25W-1A, 50W-1.8A)

Detection Equipment (Type 70A - 4 amps/system) 4.0

Customer Equipment (Carrier, loop extenders, etc.) 40.0

$$\text{Total Common Equipment Drain} \quad \underline{55.0} \text{ (C)}$$

$$\begin{aligned} \text{Total CXP-5 Drain} &= 0.8 \times [\underline{A} + \underline{B} + \underline{C}] \\ &= 0.8 \times \underline{311.1} = \underline{248.9} \end{aligned}$$

Exhibit G

Automatic Electric No. 1 - EAX

Line Drain

Number of lines x 0.027 amps/line (A)

Trunk Drain

Number of trunks x 0.15 amps/trunks (B)

Busy Hour Drain = A + B = (C)

Peak Busy Hour Drain = 1.33 x C = (D)

Common Control Drain

Up to 15,000 lines - 250 amps
More than 15,000 lines - 510 amps (E)

Customer Equipment Drain

As Required (F)

Total Busy Hour Drain = C + E + F

Total Peak Busy Hour Drain (Power Board) = D + E + F

Example: The following information is used to demonstrate the method for calculating the busy hour current drain of the Automatic Electric No. 1 - EAX:

4000 Lines -- 800 Trunks -- 100 Amps, Customer Equipment Drain

Calculation:

| | | |
|------------------------------|---|----------|
| 4000 lines x 0.027 amps/line | = | 108 amps |
| 800 trunks x 0.15 amps/trunk | = | 120 amps |
| Busy Hour Drain | | 228 amps |

Peak Busy Hour Drain = 1.33 x 228 = 303.2 amps

Common Control Drain = 250 a
Customer Equipment Drain = 1

Total Busy Hour Drain = 228+
Total Peak Busy Hour Drain =

EXHIBIT H

North Electric NX-1D

Formula 1 for Class 5 offices - includes all trunks:

Average BH Current Drain =

Number of Lines x CCS per line x 0.025 amperes

_____ x _____ x 0.025 = _____

Customer Equipment Drain = _____

Total Drain = _____

Formulae for Class 4/5 offices or Class 5 offices with ticketing:

1. Line Group Drain =

Number of Lines x CCS per line x 0.014 amperes

_____ x _____ x 0.014 = _____

2. One-way trunk, excluding intertoll, Drain =

Trunks CCS x 0.01 amperes

_____ x 0.01 = _____

3. Two-way, and one-way intertoll, trunk Drain =

Trunks CCS x 0.0174 amperes

_____ x 0.0174 = _____

4. Toll Recording Trunk Drain =

Trunks CCS x 0.05 amperes

_____ x 0.05 = _____

5. TSD Equipment Drain =

TSD CCS x 0.015 amperes

_____ x 0.015 = _____

6. Customer Equipment Drain = _____

Total Drain = 1 + 2 + 3 + 4 + 5 + 6 = _____

Calculating drain for Group Selector, Translator and Number Group:

Group Selector and Translator

1.5 amps per frame

Number Group

1.0 amp per frame

EXHIBIT I

North NX-1E

The current drain for the electromechanical portion of the NX-1E is calculated in the same manner as the NX-1D. To calculate the drain of the electronic part of the NX-1E, the following figures should be used:

| <u>Uprights</u> <u>Fully Equipped</u> | <u>Average Drain</u> <u>Per Upright</u> |
|---|--|
| Receiver-Sender Originating (RSO) | 11 amps |
| RSO - Auxiliary | 7 |
| Receiver-Sender Incoming (RSI) | 10 |
| Key Call Receiver/MF Receiver (KCR/MFR) (Assume all MFR's) | 4 |
| KCR/MFR Auxiliary (Assume all MFR's) | 4 |
| KCR/MFR (Assume all KCR's) | 6 |
| KCR/MFR Auxiliary (Assume all KCR's) | 7 |
| Key Call/MF Receiver Link (MFL) | 3 |
| Trunk Register Link (TRL) | 6 |
| 500-Line Group | Number of Lines x UC/L x 0.0075 |
| 3-Stage Group Selector | 14 |
| CPU Pair | 17 |
| Data Memory | 15 |
| Miscellaneous Data Transfer Unit | 3 |
| Tape Unit | 5 |

North NX-1D and NX-1EExample

The following data is used to demonstrate the method used to calculate the current drain of the North NX-1D and the electromechanical portion of the NX-1E. The necessary information to calculate the required drain of the NX-1E electronic circuits is shown in Exhibit I.

| | |
|-------------------------------|----------|
| Class 5 Office | |
| 2000 Lines | |
| 2.0 CCS/Line Originating | |
| Customer Equipment Drain | 40 Amps |
| Class 5 Office with Ticketing | |
| 2000 Lines | |
| 2.0 CCS/Line Originating | |
| 100 Two-Way Intertoll Trunks | 2800 CCS |
| 100 Two-Way EAS Trunks | 2800 CCS |
| 75 One-Way Toll Completing | |
| Trunks | 2000 CCS |
| 75 One-Way Intertoll Trunks | 2000 CCS |
| 125 Toll Recording Trunks | 3600 CCS |
| 12 TSD Positions | 1200 CCS |
| Customer Equipment Drain | 40 Amps |

EXAMPLE

North Electric NX-1D

Formula 1 for Class 5 offices - includes all trunks:

Average BH Current Drain =

Number of Lines x CCS per line x 0.025 amperes

$$\underline{2000} \times \underline{2.0} \times 0.025 = \underline{100}$$

$$\text{Customer Equipment Drain} = \underline{40}$$

$$\text{Total Drain} = \underline{140}$$

Formulae for Class 4/5 offices or Class 5 offices with ticketing:

1. Line Group Drain =

Number of Lines x CCS per line x 0.014 amperes

$$\underline{2000} \times \underline{2.0} \times 0.014 = \underline{56.0}$$

2. One-way trunk, excluding intertoll, Drain =

Trunks CCS x 0.01 amperes

$$\underline{2000} \times 0.01 = \underline{20.0}$$

3. Two-way, and one-way intertoll, trunk Drain =

Trunks CCS x 0.0174 amperes

$$\underline{7600} \times 0.0174 = \underline{132.2}$$

4. Toll Recording Trunk Drain =

Trunks CCS x 0.05 amperes

$$\underline{3600} \times 0.05 = \underline{180.0}$$

5. TSD Equipment Drain =

TSD CCS x 0.015 amperes

$$\underline{1200} \times 0.015 = \underline{18.0}$$

6. Customer Equipment Drain = 40.0

$$\text{Total Drain} = 1 + 2 + 3 + 4 + 5 + 6 = \underline{446.2}$$

EXHIBIT J

Northern Electric SP-1 (2 Wire)

I. Negative 48-Volt Current Consumption

| | | |
|--------------------------------------|---|----------|
| Constant | | 125 amps |
| <u>Total Busy Hour Calls</u> x 1 amp | = | |
| 1000 | | |
| (Minimum 10 amperes) | | |
| Incoming CCS x 0.01 | = | |
| Outgoing CCS x 0.00925 | = | |
| Originating Intraoffice CCS x 0.0145 | = | |
| Total Negative 48-Volt Current Drain | = | |

Notes:

1. In offices with short loops, add 20 amperes per 10,000 lines. Where loops are long, subtract 20 amperes per 10,000 lines.
2. For offices with Centrex features, add 25 amperes.

II. Positive 24-Volt Current Consumption

| | |
|--|-----------|
| A. Common Equipment (CPU's, CCTC, PMC, etc.) | 42.0 amps |
| B. Call Stores: | |
| Ferrite Sheet Memory, Basic 16K Words | 10.8 amps |
| , First Supplementary 8K Words | 8.0 amps |
| , Second Supplementary 8K Words | 2.8 amps |
| MOS Memory, Basic 16K Words | 5.1 amps |
| , Supplementary 8K Words | 1.3 amps |
| C. Program and Data Stores: | |
| Piggyback Twister Memory, Basic 16K Words | 5.2 amps |
| , Supplementary 16K Words | 2.2 amps |
| MOS Memory, Basic 32K Words | 13.8 amps |
| , Supplementary 16K Words | 5.2 amps |
| D. Centrex Data Line Units (16 Data Lines) | 8.0 amps |
| E. LAMA | 3.0 amps |
| F. Per 1000 Line Appearances | 1.0 amps |

Northern Electric SP-1Example

The following data is used to demonstrate the method of calculating the negative 48-volt current drain of the Northern Electric SP-1 system.

| | |
|---|------------|
| Total Busy Hour Calls (Originating and Terminating) | 12,000 BHC |
| Incoming CCS | 3000 CCS |
| Outgoing CCS | 3000 CCS |
| Originating Intraoffice CCS | 4000 CCS |

The majority of subscriber loops are 1900 ohms or less.

EXAMPLE

Northern Electric SP-1 (2 Wire)

I. Negative 48-Volt Current Consumption

| | | |
|--|--------------------------------|--------------|
| Constant | | 125 amps |
| <u>Total Busy Hour Calls x 1 amp</u> 1000 (Minimum 10 amperes) | $\frac{12,000}{1000} \times 1$ | = 12 |
| Incoming CCS x 0.01 | $3000 \times .01$ | = 30.0 |
| Outgoing CCS x 0.00925 | $3000 \times .00925$ | = 27.8 |
| Originating Intraoffice CCS x 0.0145 | $4000 \times .0145$ | = 58.0 |
| Total Negative 48-Volt Current Drain | | = 252.8 |
| Add for short loops | | + 20.0 |
| | | <u>272.8</u> |

Notes:

1. In offices with short loops, add 20 amperes per 10,000 lines. Where loops are long, subtract 20 amperes per 10,000 lines.
2. For offices with Centrex features, add 25 amperes.

EXHIBIT K

Nippon Electric Crossbar Systems
(NC-10, NC-23, NC-400 and NC-460)

I. Negative 48-Volt Main Power Requirement

A. Average Current Drain

$$I_{av} = (A+B) \times C \times \frac{K}{36} \quad \text{where}$$

I_{av} = Average Current in Amperes

A = Originating CCS Per Line

B = Terminating CCS Per Line

C = Number of Lines

K = 0.41 for NC-10

K = 0.51 for NC-23

K = 0.53 for NC-400 and NC-460

B. Peak Current Drain

$$I_{pk} = I_{av} + 4.48 \sqrt{I_{av}} \quad \text{where}$$

I_{pk} = Peak Current in Amperes

I_{av} = Average Current in Amperes

II. Positive 50-Volt Power Requirement

A. 0.58 amps per Dial Tone Marker (NC-400)

B. 1.42 amps per Completing Marker (NC-400)

C. 1.42 amps per Marker (NC-23, NC-460)

Nippon Electric Crossbar SystemsExample

The following data is used to demonstrate the method of calculating the current drain for the NC-10, NC-23, NC-400 and NC-460 systems.

| | |
|-----------------------------|--------------|
| Originating CCS Per Line | 1.6 CCS/Line |
| Terminating CCS Per Line | 1.6 CCS/Line |
| Number of Lines | 2000 Lines |
| Dial Tone Markers (NC-400) | 3 |
| Completing Markers (NC-400) | 3 |
| Markers (NC-23, NC-460) | 3 |

Negative 48-volt Main Power Requirement:

NC-10

$$I_{av} = (1.6 + 1.6) \times 2000 \times \frac{.41}{36} = 73 \text{ amps}$$

$$I_{pk} = 73 + 4.48 \sqrt{73} = 111.3 \text{ amps}$$

NC-23

$$I_{av} = (1.6 + 1.6) \times 2000 \times \frac{.51}{36} = 90.7 \text{ amps}$$

$$I_{pk} = 90.7 + 4.48 \sqrt{90.7} = 133.3 \text{ amps}$$

NC-400 and NC-460

$$I_{av} = (1.6 + 1.6) \times 2000 \times \frac{.53}{36} = 94.2 \text{ amps}$$

$$I_{pk} = 94.2 + 4.48 \sqrt{94.2} = 137.7 \text{ amps}$$

Positive 50-volt Power Requirement:

NC-23 and NC-460

$$3 \times 1.42 = 4.26 \text{ amps}$$

NC-400

$$3 \times 0.58 + 3 \times 1.42 = 6 \text{ amps}$$

EXHIBIT LPower Requirements for Stromberg-Carlson
Toll Ticketing Equipment

The following busy hour current drains should be used when calculating power requirements for Stromberg-Carlson automatic toll ticketing equipment:

- 1.0 ampere per recorder
- 2.0 amperes per identifier (usually 1 identifier)
- 4.0 amperes per data register (1 register/3.5 trunks)
- 2.0 amperes per sender (1 sender/4 recorders)
- 4.0 amperes miscellaneous

Example:

An automatic toll ticketing system contains the following equipment: 17 recorders, 1 identifier, 4 data registers and 4 senders.

The following drains are totaled:

| | | | |
|----------------|----------|---|------------|
| Recorders | 17 x 1.0 | = | 17 |
| Identifier | 1 x 2.0 | = | 2 |
| Data Registers | 4 x 4.0 | = | 16 |
| Senders | 4 x 2.0 | = | 8 |
| Miscellaneous | | | <u>4</u> |
| Total Drain | | | 47 amperes |

EXHIBIT M

ITT Tel Touch

The following formulae should be used to calculate the additional busy hour current drain when ITT Tel Touch (pushbutton dialing) equipment is installed:

1. Total Originating Call Drain

$$\frac{\text{Total Originating Traffic (UC)}}{36} \times 0.046 = \text{_____ amps}$$

2. Traffic to Register Drain*

$$\frac{\text{BHC} \times \text{Register Holding Time}}{3600} \times (\text{Register Current} + 0.04) = \text{_____ amps}$$

$$\text{BHC} = \frac{\text{Unit Calls} \times 100}{\text{Call Holding Time}}$$

$$\text{Register Holding Time (RHT)} = 2.5 + (1.5 \text{ seconds/digit} \times \text{number of digits})$$

*Repeat this calculation for each type of traffic to registers, i.e., local, toll, CAMA, EAS, etc.

Register Current Table

| <u>Number of Digits Handled</u> | <u>Current</u> |
|---------------------------------|----------------|
| 1 | 1.2 |
| 2 | 1.2 |
| 3 | 1.5 |
| 4 | 1.5 |
| 5 | 1.65 |
| 6 | 1.65 |
| 7 | 2.0 |
| 8 | 2.0 |
| 9 | 2.3 |
| 10 | 2.3 |
| 11 | 2.55 |
| 12 | 2.55 |
| 13 | 2.8 |

Exhibit M Continued-2

3. Allotter Drain

$$\text{Total BHC} \times 0.00047 = \underline{\hspace{2cm}} \text{ amps}$$

4. Peak Drain

$$\text{Total Drain} (1 + 2 + 3) \times 1.03 = \underline{\hspace{2cm}} \text{ amps}$$

Example:

A 300-line office equipped with 100% Tel Touch has the following traffic parameters:

$$\text{Total Originating Traffic} = 300 \text{ lines} \times 1.4 \text{ UC/L} = 420 \text{ UC}$$

$$9 \text{ Toll Trunks} = 126 \text{ UC} + 2 = 63 \text{ UC}$$

$$7 \text{ EAS Trunks} = 84 \text{ UC} + 2 = 42 \text{ UC}$$

Equal traffic is assumed in both directions on 2-way trunks.

$$\text{Total Local Originating Traffic} = 420 - (63 + 42) = 315 \text{ UC}$$

Assume 120 second holding time.

$$\text{Local Originating BHC} = \frac{315 \times 100}{120} = 263 \text{ BHC}$$

Toll holding time is assumed to be 270 seconds.

$$\text{Toll Originating BHC} = \frac{63 \times 100}{270} = 23 \text{ BHC}$$

EAS holding time is assumed to be 150 seconds.

$$\text{EAS Originating BHC} = \frac{42 \times 100}{150} = 28 \text{ BHC}$$

Local Traffic - 7 Digits

Toll Traffic - 1 Digit

EAS Traffic - 7 Digits

Register Holding Time (RHT) - Local

Register Holding Time (RHT) - Toll

Exhibit M Continued-3

The following shows the calculation of the busy hour current drain:

$$1. \text{ Total Originating Call Drain} = \frac{420 \times .046}{36} = .54 \text{ amps}$$

$$2. \text{ Local Traffic to Register Drain} = \frac{263 \times 13}{3600} \times (2+.04) = 1.94 \text{ amps}$$

$$\text{EAS Traffic to Register Drain} = \frac{28 \times 13}{3600} \times (2+.04) = .21 \text{ amps}$$

$$\text{Toll Traffic to Register Drain} = \frac{23 \times 4}{3600} \times (1.2+.04) = .03 \text{ amps}$$

$$3. \text{ Allotter Drain} = (263 + 28 + 23) \times .00047 = .15 \text{ amps}$$

$$\text{Total Drain} = 2.87$$

$$4. \text{ Peak Drain} = 2.87 \times 1.03 = 3.0 \text{ amps}$$

EXHIBIT N

Stromberg-Carlson Tone Dialing

To calculate the current drain of Stromberg-Carlson tone dialing equipment, use one ampere for each converter.

To calculate the number of converters required, use the following formula:

$$\frac{\text{Number of Lines} \times \text{UC/L}}{\text{Avg. Call Holding Time}} \times \text{Average Converter Holding Time} = \text{UC to Converters}$$

Using the P.01 Table, find the number of converters required.

Example:

Given:

400 Lines

1.5 UC/L

Call Holding Time - 180 seconds

Converter Holding Time - 10 seconds

Find current drain of Tone Dialing equipment.

Using the above formula, the traffic to the converters is

$$\frac{400 \times 1.5}{180} \times 10 = 33.3 \text{ UC}$$

From the P.01 Table, 5 converters are required. Therefore, the current drain is

$$5 \times 1 \text{ amp/converter} = 5 \text{ amps}$$

EXHIBIT 0

Transmission Electronics Current Drain

| <u>Equipment</u> | <u>48-Volt Battery Drain Amperes Per Unit</u> |
|---|---|
| Loop Extenders | 0.075 |
| <u>VF Repeaters</u> | |
| 1. Negative Impedance | 0.035 |
| 2. Hybrid | 0.035 |
| 3. Automatic Gain Control | 0.080 |
| 4. Loop Extender - Repeater Combination | 0.100 |
| 5. Automatic Gain Control Loop Extender - Repeater Combination | 0.200 |
| <u>Carrier Systems</u> | |
| 1. D1/T1, D2/T1, or D3/T1* | 3.0 |
| 2. TCS-28 | 3.0 |
| 3. N3 | 3.0 for 1 system and 5.1 for 2 |
| 4. N1 or N2 | 1.8 |
| 5. 24-Channel PCM Subscriber Systems - CO End | 3.0 |
| 6. D960 | 6.0 |
| 7. Station Carrier Channel** | 0.13 |

*Note 1: Central office terminal current is approximately 2.0 amperes and span power supply current is 1.0 ampere. Add an additional ampere if a spare span line is used.

**Note 2: The power requirements for multichannel types of station carrier depend on the manufacturer, type of equipment (including specific options), and the system length. Refer to the carrier manufacturer's literature for specific central office battery current requirements (about 0.06 to 0.25 amperes per carrier channel). For estimating purposes, allow 0.13 amperes per carrier channel. The power requirements for the one channel station carrier is about 0.035 amperes per carrier channel.

EXHIBIT P

Estimating Telephone Battery Sizes to
Meet Various Reserve Requirements

| <u>Number of Busy Hours Reserve</u> | <u>8-Hour Ampere Hour Capacity Required for Each Ampere of Busy Hour Load</u> | | | | |
|---|---|-------------|-------------|-------------|-------------|
| | <u>Final Cell Voltages</u> | | | | |
| | <u>1.75</u> | <u>1.80</u> | <u>1.85</u> | <u>1.90</u> | <u>1.95</u> |
| 1 | 2.2 | 2.5 | 2.8 | 3.5 | 5.0 |
| 2 | 3.2 | 3.4 | 3.7 | 4.7 | 6.2 |
| 3 | 4.0 | 4.3 | 4.7 | 5.6 | 7.5 |
| 4 | 4.9 | 5.1 | 5.6 | 6.5 | 8.6 |
| 5 | 5.7 | 6.0 | 6.5 | 7.4 | 9.6 |
| 6 | 6.5 | 6.8 | 7.3 | 8.2 | 10.6 |
| 7 | 7.2 | 7.6 | 8.1 | 9.1 | 11.6 |
| 8 | 8.0 | 8.3 | 8.9 | 10.0 | 12.6 |
| 9 | 8.8 | 9.1 | 9.6 | 10.9 | 13.7 |
| 10 | 9.5 | 9.9 | 10.4 | 12.0 | 15.0 |

Examples:

1. Required: The capacity of a 24-cell battery to handle a 3-hour load of 34.0 amperes to a limiting voltage of 44 volts.

$$\frac{44}{24} = 1.83 \quad \text{Use 1.85 Volts}$$

From the above chart each ampere of busy hour load requires 4.7 ampere hours of capacity.

Total capacity required = $4.7 \times 34.0 = 160$ ampere hours.
Select the next larger catalog size.

2. Calculate the ampere hour reserve of an existing 24-cell, 480-ampere hour battery with the busy hour load increased to 84 amperes to a final voltage of 1.75 volts.

Formula: $K = \frac{B}{C}$

where

K = 8-hour ampere hour capacity required of busy hour load.

B = Ampere hour capacity of existing battery

C = Actual busy hour current drain of battery

$$K = \frac{480}{84} = 5.7$$

On the chart, locate 5.7 in the 1.75-volt column. The left read 5 hours' reserve.

